LIFE HISTORY AND HABITS OF TROGODERMA TARSALE (MELSH.), A MUSEUM PEST.

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1. Description.

H. F. Jayne (1882) in his "Revision of the Dermestidæ of the United States" gives the following description of *Trogoderma tarsale*, which he says is identical with *T. inclusum*:

"T. inclusum (Lec.)—Oval, somewhat oblong, black, clothed with moderately long, semi-erect black pubescence. Elytra with four sinuous confluent bands of red, bearing whitish pubescence. Head coarsely and densely punctured, quite sparsely pubescent. Eyes deeply emarginate in front, not very prominent. Antennæ testaceous. Thorax finely punctate, moderately pubescent. Elytra black, with four irregular bands of red, bearing grayish pubescence, the rest with sparse black pubescence, coarsely punctate. Body beneath piceous, coarsely punctate, with cinereous recumbent pubescence. Antennal fossa deep, occupying nearly all the space between the front and lateral margins. Prosternum short, moderately wide, convex, not carinate. Abdominal segments rufous, apical margins paler, pubescent. Legs rufo-testaceous. Length .08—.16 inch; 2—4 mm. Male antennal joints 1 and 2 large, 3—4 very small, 5—11 forming the club, which is not deeply pectinate.

"Female. Antennal joints 1 and 2 large, 3—7 small, 8—11 forming the club. T. tarsale and T. pallipes are identical with this species."

F. H. Snow (1882) gives the following description of the larva and pupa. "In Dr. Hagen's list of Museum pests observed in Cambridge," published in the Proceedings of the Boston Society of Natural History, Vol. XX, I find no mention of the above species, and in order that eastern collectors may guard against its introduction into their cabinets I give the following brief description of its larva and pupa.

LARVA.

"Measurements, when full grown: Length, exclusive of caudal hairs, 5.4 mm.; inclusive of caudal hairs, 8 mm.; breadth, 1.6 mm. Upper dermal surface reddish brown; lower surface vitreous white; entire surface covered with short, soft, yellowish brown hairs; each stigmatic orifice surrounded by a stellate tuft of longer setose hairs, of variable length and of the same color as the general hairy covering. The upper surface of the last three segments is entirely concealed by a dense mass of short, erect dark brown hairs so nearly equal in length as to present the appearance of having been cut off with shears, like the bristles of a very compact brush. The sides of the upper surface of the two preceding segments have a similar covering. The two caudal appendages, which attain one-half the length of the body are noticeably separated when the larva is in motion, often appear to the eye to consist each of a single, stout, elongated bristle, but, under the microscope, are seen to be composed in each case of from twenty to twenty-five hairs.

PUPA.

"Length, 4 mm.; breadth, 2 mm.

"Enclosed within the larval skin, and visible only from above, where the larval skin is longitudinally split open along the median dorsal line from head to anal segment. Abruptly narrows to a point at the anal extremity. Removed from larval skin, the entire surface of the pupa is seen to be covered with short, soft, light yellowish brown hairs, except at the center of dorsal surface which contains three minute transverse incisions or furrows. The anterior margin of each furrow is straight while the posterior margin is curved. Examined under the microscope, both margins of each incision are seen to be minutely dentate, but the teeth of the posterior margins are more prominent than those of the anterior margins."

Dr. Snow has apparently obtained and measured larvæ of the average size, for the larvæ attain a much larger size than 5.4 mm. We have collected and raised a large number of specimens which have attained the size of 7 mm., and not infrequently do we obtain larvæ as long as 8 mm., exclusive of the caudal hairs, and 10 mm. including the caudal hairs. The breadth of such specimens is 2.5 mm. Very frequently in the full grown larvæ the upper surface of the last five segments is entirely concealed by the dense mass of hairs and the sides of the upper surface of as many as four of the preceding segments have a similar covering.

The life history of T. tarsale has never been worked out, and a few scattered notes, most of which are subsequently quoted in this paper, comprise the literature on this well known museum pest.

2. Distribution and Damages.

C. V. Riley (1883) says, "It is in fact the most common museum pest in this country and it is strange that Dr. Hagen in his paper on museum pests does not mention it. It is by no means peculiar to the West as the Professor seems to suppose. Here in Washington it is by far the most dangerous enemy to insect collections, and much more frequent than Anthrenus varius. In the field its larva is occasionally found in the cracks of hollow trees and similar situations, feeding on dead insects, but it is far more common in the deserted cells of Pelopoeus, Odynerus, Anthophora and other Hymenoptera, that store their cells with spiders or other insects."

The various notes on this beetle plainly indicate that in the United States it is distributed from coast to coast, and that it is especially abundant in the northern states. As a museum pest no other beetle can do more harm than T. tarsale which when once introduced into a building, is by no means easy to exterminate. Mounted insects especially suffer from the pest and large collections are often wholly destroyed by the larvæ. Here at the University of Wisconsin, as well as in numerous other places, in spite of the great pains taken in frequently inspecting the insect boxes, and in keeping them tightly covered, a large number of useful as well as rare specimens belonging to Dr. William S. Marshall are annually destroyed by the larvæ. Dr. Marshall says that they have even entered Riker mounts and eaten the insects contained therein. Not only do the larvæ attack animal matter such as dried insects, cocoons, furs, skins, wool, feathers, etc., but very frequently they are found devouring vegetable matter as cereals, seeds of all sorts, nuts, and even spices. In the University Drug Collection they were found by the thousands devouring flax and cotton seeds which had been stored away for a long time.

F. H. Chittenden (1895) in a paper on some Dermestidæ says, "T. tarsale Melsh., a common museum pest, was found to infest flax seed, castor beans, and cayenne pepper that had been on exhibition in the museum of the U. S. Dept. of Agric., the larvæ being reared from the eggs deposited in these substances and the adults having been bred from other larvæ feeding on them."

L. O. Howard (1904) in the extracts from correspondence gives the following note: "Dr. George S. Yingling, Tiffin, Ohio, sent to this office (U. S. Dept. of Agric.) with accompanying letter dated May 30, 1903, a glass charm with sterling silver band, inclosing a common French beetle, frequently used as an ornament, together with larva of the cabinet beetle (T. tarsale) which was destroying it. By careful examination of the top of the charm it was seen that there was a crack large enough for the admission of the larva when it was young."

Another note, found in Insect Life (1894) is as follows: "Trogoderma tarsale (Melsh.). Breeding by thousands in silkworm cocoons in the U. S. Gov't Bldg,, a well-known museum pest, probably identical with European species."

3. Life History.

T. tarsale may be found in all stages of development throughout the year in well-heated buildings. Under favorable conditions such as are found in the average museum, with the ordinary room temperature and plenty of food, I have obtained two and a partial third generation in one year. Some of the specimens which hatched in January metamorphosed in June and some of their young in turn matured and laid eggs in October, thus giving rise to a third generation before the end of the year.

The beetles usually pair on the day following their emergence from the pupal skins. The eggs, varying in number from as few as three to as many as sixty, are laid in convenient places from three to five days after copulation. The young larvæ hatch from ten to fourteen days later, the time depending largely on temperature. Under ordinary room temperature they hatch on the average in twelve days. The larvæ, almost immediately after hatching, begin to feed on the material at hand and, as a rule, do not wander unless the food is decidedly poor or scarce. Quite frequently a large number of them hatch in the same insect which had reared the parents and very seldom they desert it until it is almost completely devoured.

In one case eighty-six larvæ hatched in the dry body of a May-beetle (*Lachnosterna*) in which the parents had completed their life history, and, although several other dried insects were present in the same small dish, they were not attacked until the May-beetle was almost completely devoured. The

growth of the larva depends to a considerable extent on temperature and the abundance of food, and it is retarded by cold weather and scarcity of nourishment.

The foregoing factors, however, are not always the cause of slow development. I have noticed that in almost every brood there is a wide variation in the growth of the various specimens under identical external conditions. Very often some specimens attain full size, metamorphose, and produce young long before others are half grown; but not infrequently do these young overtake the other members of their parent group and even reach maturity much sooner under the same conditions. The small, oblong, white eggs are apparently all of the same size and yet some of the larvæ hatching from them seem to be unable to get started in their development. The majority of the specimens, however, mature in about the same length of time, which is from five to six months.

Another very interesting thing which occurred regularly in these studies is the fact that frequently some individuals attain an apparently full size within a comparatively short time, but do not enter the pupal stage for a surprisingly long period thereafter. These larvæ are active, continue to feed, and are normal in their behavior, but there must somewhere be a cause for the sudden halt in their development. We are keeping in the laboratory a large number of larvæ which have been full-grown for over two years, and even very favorable conditions do not seem to effect a metamorphosis. A number of specimens are being kept under different conditions, but thus far nothing entirely conclusive has been obtained.

Summary of Variations in the Life History of Different Individuals of the Same Generation.

1. The adults lay eggs from three to seven days after emergence.
2. The number of eggs laid by different individuals varies from five to sixty-two in number.
3. The eggs hatch in ten to sixteen days, depending largely on temperature.
4. Larval life lasts from five to forty months or more.*
5. The time of pupation is from eleven to seventeen days.
6. The age of adults varies from ten to thirty-two days.

*At present we have a number of live larvæ which have lived forty months.

4. Moulting.

There is an extremely wide variation in the rate of moulting and the number of larval skins shed by the different individuals of this species. In general, under normal conditions, the larvæ moult once in about every two weeks, but there are many peculiarities worthy of mention. The same specimen often sheds its skin very irregularly, sometimes within ten days and then again, under practically the same conditions, not until a period of three weeks or more has elapsed. In general, growing individuals moult more frequently than do those which have attained their full size. Specimens which are slow in their development, as a rule moult less frequently than do the larvæ which develop at the average rate. Not infrequently, however, does a decidedly slow growing specimen moult almost regularly once in every two weeks. The full grown larvæ, previously spoken of, which continue to live for a long time before entering the pupal stage, have, in general, a decidedly slow rate of ecdysis. The average rate is about once in every four weeks and this gradually decreases as the specimen grows older; but here again there is a wide variation, the different specimens moulting once in a period of time which varies from three to nine weeks.

Thus we see that the number of moults is by no means constant. The majority of the specimens which complete their life history in about five months shed their skins from eight to twelve times, whereas, many of the individuals with the prolonged larval history moulted more than twenty times. The greatest number of moults which I have recorded to the present time for any individual is thirty-two, but the number will probably be much greater as these larvæ are still alive and in apparently good condition.

The larvæ never eat their own skins nor the skins of other individuals of this species, even though they may be in a starving condition. This was conclusively proved by placing specimens singly, or in numbers, in glass vials for the purpose of starving the larvæ, and even after many months of starvation, and after the larvæ had moulted several times, the skins were never atacked.

Shortly before moulting the specimen becomes inactive, and a split soon appears in the larval skin along the median dorsal

line; this extends from the head, through the thorax and partly down the abdomen. The larva bends over and assumes a semi-circular position which permits the extrication of the thorax and head. The legs are then pulled out of their coverings and the light colored larva crawls out of the exuvia. Its new, soft, chitinous covering soon hardens and assumes the natural yellowish brown color within a few hours.

C. V. Riley (1883) in an article on the number of moults and length of larval life as influenced by food, says, "Since March 13, 1879, we have kept two larvæ of that common museum pest (Trogoderma tarsale) in a light tin box with an old silkworm cocoon. They were half grown when placed in the box. On Nov. 8, 1880, there were in the box twenty-eight larval skins, all very much of a size, the larvæ having apparently grown but little. The skins were removed and the box closed again as tightly as possible. Recently, or after a lapse of two years, the box was again opened and we found one of the larvæ dead and shriveled up, but the other was living and apparently not changed in appearance. There were fifteen larva skins in the box. We cannot tell when the one larva died, but it is certain that within a little more than three and one-third years two larvæ shed not less than 43 skins, and that one larva did not, during that time, appreciably increase in size.

"We know of no observations which indicate the normal or average length of life or number of molts in either Tenebrio or Trogoderma, but it is safe to assume from what is known, in these respects, of allied species, that in both the instances here referred to, but particularly in the case of Trogoderma, development was retarded by insufficient nutrition and that the frequent molting and slow growth resulted therefrom and were correlated."

My observations and numerous experiments on the starvation of T. tarsale do not corroborate Riley's statement that insufficient nutrition of larvæ in all stages of development show that a lack of nutrition retards the frequency of moulting. Specimens which ordinarily on favorable diet moulted once in two weeks, moulted on the average less than half as frequently when deprived of food.

Summary of Variations in Moulting.

1. Larvæ shed their first skin from four to nine days after hatching.

2. The period between the next succeeding moults, in growing individuals, varies from nine to thirty-six days.

3. The number of moults in different individuals varies from eight to thirty-two or more.*

4. The rate of moulting in full grown larvæ, more than one year old, is once in eighteen to sixty-five days.

5. Specimens under starvation moult once in fourteen to seventy-eight days.

5. Pupation.

When the larva reaches full growth the pupa begins to form within the last larval skin; and from three to five days later the skin splits down the median dorsal line and the light-yellowish pupa is exposed. The period of pupation lasts from eleven to seventeen days, though this may be considerably increased by low temperature, and we have noticed that the males are somewhat more precocious than the females. When the insects are fully developed they emerge through the large dorsal opening of the pupal skin. Should a specimen be forced out of the larval case when not fully matured though capable of locomotion, it invariably returns to its former position within the protective larval skin upon coming in contact with it. The females, after their elytra attain the dark adult color, usually remain in the pupal cases a day or two longer than the males. The average life of the adult insect lasts about three weeks.

6. Courtship and Mating.

The females, on the day of their emergence, avoid the male specimens, but the following day or later they become submissive and copulation takes place. The male on coming in contact with a sexually excited female rubs his antennæ against her abdomen and then quickly turning around brings the point of his abdomen in contact with that of the female. Promiscuous mating is general; a male usually impregnates a number of females and a female usually accepts several males. It might be well in this connection to mention the fact that the sense of smell is not well developed in this species. Experimental work shows that male specimens are unaware of the presence of sexually excited females, even when they are but a very short distance apart.

*Some of the larvæ previously mentioned as having already lived almost three and a half years, have up to the present time moulted thirty-two times.

A large number of females, immediately after the completion of metamorphosis, were placed in separate vials and not allowed to be fertilized. In a single case only were there any eggs laid and those were only three in number. The life of non-pregnant females is, in general, somewhat prolonged. It was also found that extremely small female specimens are sterile.

7. Feeding.

The wide variety of substances upon which this species can subsist has already been mentioned when speaking of their ravages, but it might be well to give the relative value of some of the substances as food for the larvæ. The pests seem to thrive best on dried insects and fish, and although they can live on wool and feathers their growth is decidedly slow when they feed on these materials. A number of specimens immediately after hatching were placed on a feather diet and, although they are now over two years old, they have grown but very little, When they were a year old they were very little larger than the newly hatched individuals, and at the end of the second year of life, they reached a meager size equal to that which specimens fed on insects ordinarily attain in two weeks. Their development on wool is even slower.

F. H. Chittenden (1897) says, "One jar of flaxseed from the museum exhibit of the department is infested chiefly by this common museum pest. Many of the larvæ may be seen through the glass, and large patches of their yellowish-brown gnawings and excrement show where they have been at work. In castor beans a few larvæ were present.

"That these species of Trogoderma can subsist on a vegetable diet is as positive as it is surprising. No other Coleoptera to my knowledge live on oil seeds, and I had nearly arrived at the conclusion that as this form of matter was the nearest approach to animal food available, that these insects could only thrive on such vegetable substances as contain a considerable portion of oleaginous matter. Judge of my astonishment, then, when a few weeks after the discovery of the Trogoderma living in oil seeds, Dr. Howard brought me a box nearly full of cayenne pepper in which were several Trogoderma larvæ. The most careful search failed to show even fragments of that well-known red pepper pest, Sitodrepa panicea, or of any other insect than the dermestid. Subsequently the adult was reared and proved to be Trogoderma tarsale.

"It seeming desirable to ascertain if this species would breed on so pungent a substance as cayenne pepper, a few adults were confined with a quantity of this condiment. In due time larvæ appeared and when examined August 20, or nearly ten weeks from the time the eggs were deposited, were in vigorous condition, the average individual measuring a tenth of an inch in length, or about half that of the full-grown larva. Toward the end of September, while passing through the museum of this department, my attention was attracted by an accumulation of powder and dust about the edges of an exhibit of peanut oil cake, and another of Indian turnip bulbs. A great number of the larvæ and their cast skins were found under and on the under surface of the cakes; also in flour and meal prepared from peanuts. The Indian turnip bulbs were very old and dry, and might have been on exhibition twenty years or more.

"When this insect infests a substance of similar color and consistency to flour and meal only a few larvæ are sufficient, on account of their extraordinary habit of frequently molting, to occasion alarm. In fact, appearances are much worse than the reality. Thus, in a small box of peanut meal in which these larvæ had taken up their abode, about forty larval skins had accumulated when examined September 27, completely covering one-half of the surface of the meal, and giving the impression of a whole colony of the insects.

"After the experiences narrated I was prepared for almost anything, and was expecting that as this species was as nearly omnivorous as the preceding, it would in time be found like them to be granivorous. Having convinced myself by the process of 'reasoning by analogy' that the insect *must* be a grain feeder, I had resolved to experiment with a view of ascertaining if the species would feed upon cereal food. A compulsory delay of a few days saved me the trouble. While the Division of Entomology was moving into new quarters a bag of "Saskatchewan fif" spring wheat, formerly kept in stock for gratuitous distribution, and described on the label as a hard, amber variety with an exceedingly heavy grain, was unearthed, in which the larva of this insect was living, there being present no other insects except a colony of Anthrenus and a single stray Silvanus. In fact, this grain is so hard and flinty that weevils would not flourish on it.

"Soon afterwards I found larvæ in another lot of wheat infested with Silvanus, and in corn containing *Calandra oryza* and other small beetles. About the same time, Mr. Frank Benton brought me larvæ found in beehives, where they apparently fed upon propolis, or bee glue. There are several recorded instances of *Dermestes lardarius* feeding upon wax,* or, more properly speaking, honeycomb, and it is therefore fairly certain that Trogoderma has the same habit, although not previously reported in beehives.

"Among the divisional notes I find one recording the receipt of six larvæ of this species in a box of red pepper, from a correspondent in Utah, November 22, 1882. These larvæ were kept in the box of pepper for a year, at which time fifty-four cast skins were noticed. The box was examined January 14, 1887, or over four years from the time of its receipt, when two larvæ and seventy more cast skins were found, but no trace of beetles, although it had been kept closed, so that it was impossible for either larvæ or adults to escape. It is very obvious that four larvæ, or the beetles that developed from them, had died in the interim and were then devoured by their fellows. In any case, the adult was not reared, and no published statement was made of the larva having been found living in the condiment.

"The capability of this species to breed in other seeds was demonstrated by the discovery of the larvæ living upon "kolu", an edible leguminous seed somewhat resembling a cowpea. The insect had evidently been first attracted by the dead bodies of the original inhabitant of the seeds, the weavil, *Bruchus chinensis*, but had afterwards fed upon the seeds, even hollowing them out and leaving only the empty shells. In a similar manner, larvæ were found, together with those of Attagenus, in millet and pumpkin seeds that had formerly been inhabited by the polyphagous Indian-meal moth, *Plodia interpunctella.*"†

In the case of the six larvæ found in the red pepper it is not likely that four of them metamorphosed, because if they had it is certain that they would not have been entirely devoured by

*See Lintner's 6th Report, pp. 122–123; Dubini (L'Ape e il suo Governo, 1881, p. 266.)"

"†Since the preparation of this paper was completed Dr. John Hamilton has recorded the breeding of Trogoderma tarsale in packed figs (Canadian Entomologist, Vol. XXVIII, p. 262, Oct., 1896)."

their fellows. The hard chitinous covering and the elytræ are never completely devoured even by starving specimens. It is much more probable that they died in the larval stage and were later devoured by the other two larvæ; or they might have shrivelled up and darkened, and were thus easily overlooked. That the two larvæ which were present four years later were two of the original six is highly probable. There are several larvæ in our laboratory which were obtained three years ago, when they were full grown, and they have apparently not changed any since.

8. Variation in Size. Among the Adults.

The adult male specimens are smaller, as a rule, than the female insects, but the small individuals are not necessarily always males. There is an extemely wide variation in the sizes of both sexes which in the adult stage vary from 1.25 mm. to 4 mm. in length, the width also being proportionate. It is difficult to determine just what is the cause of such a pronounced difference. Although poor nutrition gives rise, in general, to smaller insects, very small individuals also appear among the large ones which have lived under very favorable conditions. A marked variation in size of the different larvæ of the same brood is apparent within a few days after they hatch. Observations show, however, that the small, slowly developing larvæ do not always give rise to small adults, as in some cases it is merely a matter of taking more time for development.

9. Phototactic Reactions and Death Feigning.

The larvæ immediately after hatching manifest a strong negative reaction to light, concealing themselves in any available shaded area. If placed near a window they at once begin to crawl away from the light, and the reaction is even more pronounced when the specimens are taken into a dark room and a strong light is introduced at one end of the glass dish containing them. This negative phototaxis persists throughout the larval life, and just before the larvæ pass into the pupal stage the reaction becomes even more pronounced. Thus, the pupæ are almost invariably found in dark places which afford them a favorable means of protection.

The adults, both male and female, usually retain their negative response to light after emerging from their pupal skins.

During the period of sexual excitement which follows a day or two later the insects are still negative and the females remain decidedly so until their eggs are safely deposited. Several hours later, or the day following the egg-laying, they gradually become indifferent to light and finally a complete reversal of their former reaction follows. The males, too, become positively phototactic during the last days of their lives. Although ordinarily the adults remain in the cabinets where they had developed till death occurs, we find some occasionally on the windows in the rooms where they make their abode. A number of such specimens were at different times collected and dissected, but in no case were there any eggs found within the bodies of the females. This also indicates that the females lay their eggs before they reverse their reaction to light and desert their places of concealment, and apparently their destruction as a museum pest at this late stage is futile.

The larvæ in all stages of development feign death when disturbed. The period of death feigning, however, is very short, lasting only half a minute at the most and usually only a few seconds. If the disturbance is continued they no longer respond in the same manner. The adult insects when disturbed fold up their legs and antennæ and feign death for a much longer time than do the larvæ; the average feint lasting only about half a minute; but specimens frequently feign death as long as fifteen minutes. This reaction in the adults, too, wears out if the disturbance is repeated.

10. Results of Experiments on Starvation of the Larvæ.

The most interesting feature of the studies on T. tarsale is the extremely long period of time that the larvæ can go without food. Even the newly hatched specimens which never had a morsel of food to eat live as long as four months. Many of the older larvæ, which are being kept in the laboratory, have not had a particle of food during the surprisingly long period of a whole year and are still alive and active; and at this stage of the experiment it is not possible to say just how long the larvæ in various stages of development are able to exist under such conditions.

A large number of larvæ of at least eight representative stages, varying from newly hatched to full grown individuals were collected and placed in covered glass vials, without any food whatsoever, for the purpose of starvation.

Ten larvæ of each representative stage, varying from full grown to newly hatched specimens, were placed in individual vials and also a large number of all the possible combinations in two were made. For example, eight full grown larvæ 7 mm. long were placed in eight different vials and together with each of these was placed one individual of each of the other representative stages. Thus, we had a vial containing two full grown larvæ, one containing a full grown and a larva about 6 mm. in length, and so on down the series with a gradually greater and greater difference in the size of the two larvæ within the same vial, until the last one contained both a full grown and a newly hatched larva.

The same process was repeated with a larva of 6 mm., 5 mm., and so on, to the larva 1 mm. in length, and thus all the possible combinations between the larvæ of practically all sizes were made. The additional purpose of this latter experiment was to determine the extent of cannibalism among the species.

Three such large groups of vials, as that described above, were made and each was placed under somewhat different conditions. One group was exposed to day-light in the laboratory, another was kept continually in the dark, and the third in a box under a constant thirty-five candle power electric light. The last mentioned group of larvæ had a somewhat higher temperature caused by the presence of the electric light in the box.

Measurements of all the individuals were made and a careful record is being kept. The vials are examined regularly and measurements of the several individuals of each representative stage are taken and recorded. A record of the cast skins is also kept; from some of the vials the exuviæ are removed as soon as shed and in others they are allowed to remain continually for the purpose of determining whether the larvæ ever eat them. It was found that the larvæ never devour their own nor the skins of other specimens. There is absolutely no evidence of cannibalism among the larvæ; even the full grown starving specimens never attack the much smaller individuals. Practically all of the insects shed their skins shortly after they were placed without food; but between the other following ecdyses a period much longer than the normal elapsed. Careful measurements soon revealed the surprising fact that the larvæ were actually decreasing in size. In all

three of the groups many of the specimens which were less than half grown, or 3 mm. in length, at the beginning of the experiment, had reduced within about six or seven months to the minimum size of 1 mm. in length. Many of the full grown larvæ which were 7 mm. in length have fallen back to less than half this size within one year of starvation; others decrease less rapidly, some having lost only 2 mm. during the same long time. The larvæ under the constant electric light had a somewhat higher temperature and decreased more rapidly than did those of either of the other two groups; Even some of the full grown larvæ of this group had actually reduced their size within eleven months to practically the same measurements they had upon hatching, about 1 mm., and then finally died. The results of these experiments will be published in detail as soon as they are completed.

I wish to express my thanks to Prof. William S. Marshall for his suggestions and kind criticisms in preparing this paper.

Zoological Laboratory, Univ. of Wisconsin,
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EXPLANATION OF PLATE XXVII.

All drawings (except Fig. 4) made with a camera lucida. x 10. Stages in the Life History of Trogoderma tarsale (Melsh.)

Fig. 1. A full grown larva.
Fig. 2. Ventral view of pupa removed from the pupal case.
Fig. 3. Adult male.
Fig. 4. Male and female antennæ.
Fig. 5. Dorsal view of pupa as seen through the split in the pupal skin.